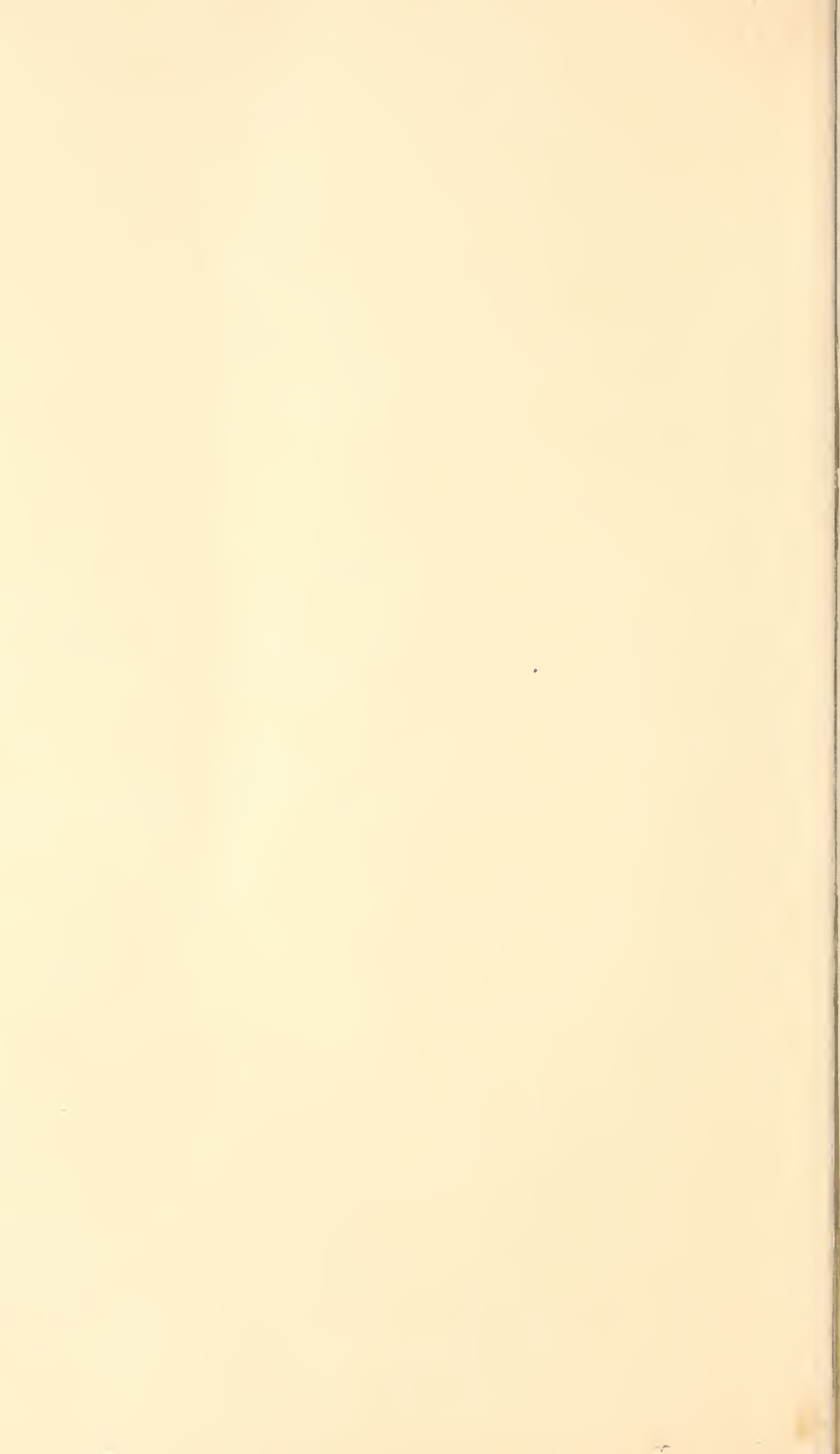


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United States Department of Agriculture,

BUREAU OF ENTOMOLOGY,

L. O. HOWARD, Entomologist.

ROOT-MAGGOTS AND HOW TO CONTROL THEM.

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The roots of vegetable crop plants of many kinds are subject to the destructive influence of maggots which injure them severely during certain seasons. Several forms of injurious root-maggots are recognized, but of these there are three species which are much more destructive than the others. The most important are the cabbage maggot and the imported onion maggot, the former a specific enemy of cabbage and

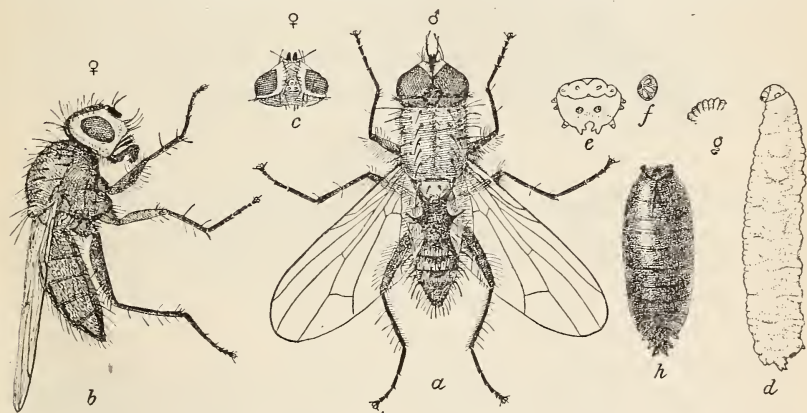


FIG. 1.—Seed-corn maggot (*Pegomya fusciceps*): *a*, male fly, dorsal view; *b*, female, lateral view; *c*, head of female from above; *d*, larva, from side; *e*, anal segment of larva; *f*, anal spiracles; *g*, cephalic spiracles; *h*, puparium—all much enlarged (author's illustration).

other cole crops, the latter of the onion. A third species, the seed-corn maggot, attacks the sprouting seeds of both onion and cole crops and of a considerable variety of other plants, afterward working into the roots and stalks beneath the earth's surface. As the last-mentioned insect is nearly omnipresent and omnivorous, it will receive first consideration. These species all belong to the genus *Pegomya* of the dipterous family Anthomyiidae.

THE SEED-CORN MAGGOT.

(Pegomya fusciceps Zett.)

Vegetable growers frequently find that seeds fail to develop, and, on looking for the cause, find a small white maggot which, from its early occurrence on seed corn, has been termed the seed-corn maggot. In more recent years it has often been associated with injury to beans,

whence another name of bean fly. Many other vegetables are subject to damage, cabbage, turnip, radish, peas, onions, beets, and seed potatoes being often much affected. The insect, which is generally distributed in the United States, is shown in its different stages in fig. 1. It resembles the common house fly. The particularly distinguishing characteristic of the fly consists of a row of short bristly hairs of nearly equal length on the inside of the posterior tibiæ or shanks of the male (fig. 1, *a*). The length of the wing is about one-fifth, and of the body, about one-sixth of an inch. There is little doubt that this insect is of European origin, and it is increasing in destructiveness in this country.¹

In its earlier stages the seed-corn maggot also resembles the house fly. The maggot is footless and cylindrical, presenting in profile the appearance represented at *d*. It measures about $\frac{1}{4}$ inch in length, and about 0.04 inch in width. The color varies from nearly white to pale yellowish.² The maggot transforms into a puparium (*h*), barrel-shaped and of elliptical outline, and pale brown in color, measuring about 0.15 inch in length and 0.05 inch in diameter. Indications are that there are several generations of this species annually, one developing in June in the North from seedlings, and later ones from roots, dead or dying plants, and other refuse.³

METHODS OF CONTROL.

Owing to the difficulty of destroying root-maggots and other subterranean pests and the cost of chemicals for the purpose, such as bisulphid of carbon, growers depend largely upon methods of prevention. To be thoroughly effective these methods should be employed before the insect's eggs are laid.

Sand and kerosene.—A method commonly used of deterring the parent flies from depositing their eggs consists in the use of sand soaked in kerosene—a cupful to a bucket of dry sand—which is placed at the base of the plants, along the rows. This also kills young maggots that may attempt to work through the mixture.

Carbolic-acid emulsion.—For all three forms of root-maggots which are being considered, a carbolized form of kerosene emulsion is effective. This is prepared by adding to 1 pound of soap boiled in 1 gallon of water, $\frac{1}{2}$ gallon of crude carbolic acid, and is diluted with from 35 to 50 parts of water.⁴ This mixture is applied about the stalks of the plants affected. It is best to use it a day or two after the plants are up, or are transplanted, and should be repeated every week or ten days until

¹ A more extended notice is furnished in Bul. 33, n. s., Div. Ent., pp. 84-92.

² In all material examined there are only 6 or 7 cephalic spiracles (*g*), whereas in the other root-maggots which will be considered there are 11 or more.

³ There is evidence that another maggot has been confused with this species.

⁴ The mixture is effected according to directions furnished in Farmers' Bulletin 127, p. 22 (1903 ed.), which will be furnished on application.

about the third week in May, in the North. Farther south these applications must be made earlier.

The use of fertilizers.—Mineral fertilizers are also useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. The principal fertilizers for this purpose are kainit, nitrate of soda, and sulphate or chlorid of potash. They should be applied either as top dressings before planting or afterward as nearly as possible to the roots, and the earth should be turned away from the plants for this purpose. They possess the advantage of acting also as a stimulant to plant growth, and facilitate recuperation from root-maggot attack.¹

Stable manure and organic fertilizers are apt to induce infestation, as this species is well known to develop in excrement and other decomposing material. Numerous instances of this nature have come to the writer's knowledge during recent years. It is advisable, therefore, to avoid the use of manure, rotted leaves, or other organic fertilizers, and not to plant in fields in which infested or diseased plants have been.

Hand methods.—As soon as seed fails to appear at the proper time or the plants show signs of wilting and maggots are known to be present, the seed should be hoed out or the injured plants pulled and destroyed, together with the young maggots.

Most of the above methods have been used with success against onion maggots and other root-feeding species, and are all that is required in many cases of ordinary infestation of vegetable roots.

THE CABBAGE MAGGOT.

(*Pegomya brassicae* Bouché.)

Cabbage and related cruciferous crop plants frequently suffer severe injury owing to the attack of the cabbage maggot. Young plants are most seriously affected by the maggots eroding the outer surface, and boring into the interior of the roots, devouring the tender rootlets, and frequently penetrating into the lower portion of the stalk.

The insect is an imported pest, known also as the radish maggot, first noticed ruining cabbage, cauliflower, and similar plants in New York State about half a century ago. This species does its most serious injury throughout the northern tier of States and Canada, attacking all forms of crucifers, whether wild or cultivated. In this region it is the cause of more or less loss to these crops year after year, but as with

¹ It is frequently necessary to use these fertilizers in large quantities. In cabbage fields a fertilizer of the proper composition is applied at the rate of 1,000 to 1,500 pounds to an acre before planting. After the plants have started growth a top dressing of 100 pounds of nitrate of soda and 200 pounds superphosphate is added. When the heads are beginning to develop a third application of about 200 pounds of nitrate of soda is often desirable. For details consult Voorhees's "Fertilizers."

other destructive insects, it is much more abundant in some seasons than in others. Since 1902 it has not only been exceedingly destructive, but has increased in injuriousness each year since. Frequently entire crops over considerable areas are completely destroyed. Two or three generations of this maggot are indicated in the Northern States, and perhaps four or five in the South.

METHODS OF CONTROL.

Since this species is also a root-feeder, the remedies prescribed for the seed-corn maggot are applicable. In addition, there are certain preventive and other measures for its destruction that have been found successful, their use being justified by the great value of cabbage plants.

Carbolic-acid emulsion, prepared as prescribed on page 2, and diluted about 35 times, is particularly applicable when this maggot occurs on radish and other plants than cabbage and cauliflower.

Mechanical methods.—Hand-picking, although laborious, has the merit of being effective, and is practiced with considerable success by extensive cabbage growers. It is not practicable on radish and similar crops. It consists in pulling up the young cabbage or cauliflower plants, examining the roots for eggs and maggots, and either destroying them by crushing them with the hand or by washing the roots in a strong solution of soap, after which they are replanted. In two or three weeks, usually, they show no effects from this treatment. By carefully watching, the minute white eggs may be seen about the stalks of young cabbage plants, and if the earth be raked away so as to expose the eggs to the sun they will dry up, thus preventing the maggots from hatching. Afterward the plants should be hilled up.

Methods of cultivation.—Experience shows that comparatively little is to be expected from different farming methods which are sometimes perfect safeguards against other insects. Whatever might be advised and found successful on one farm might, for one or more reasons, be found ineffective on another.

By keeping the soil well hilled around the plants the cabbage sends out more roots, thus affording food for the maggots and leaving enough roots to strengthen the plant itself.

Crop rotation should be followed with any other plant than a crucifer or onions. The last is inadvisable, as the same atmospheric or other conditions which induce injury by the cabbage maggot seem to operate in increasing the numbers of the onion pest. Fall plowing is also indicated.

Crop remnants of all crucifers and particularly cabbage stumps, should be removed and destroyed, especially early in the season. Late in the fall a less number of maggots would be destroyed in this way, but it is always a desirable method for the protection of the crop against other

pests which harbor in the old stalks or feed on the new leaves in early winter to appear the next spring.

Gas lime applied about each plant has often been advised as a remedy, but those who have tried it are nearly equally divided as to its efficiency. It is well worth further experiment where the gas lime can be obtained without difficulty.

The bisulphid of carbon treatment.—In case tarred paper cards, which will presently be described, or other methods here prescribed, are not used and the insect occurs in great numbers at the roots of cabbage, bisulphid of carbon may be used by injecting it with a special injector or syringe below the root system, taking care that the application is not made directly to the plants, as it is likely to kill them. A hole is made a little distance (3 or 4 inches) from the plant, and the injector is inserted at an angle as shown in figure 2.¹ After injecting the liquid the instrument should be withdrawn and the hole closed by packing it down with the foot. A teaspoonful to a tablespoonful to each young plant and a single application is generally sufficient.



FIG. 2.—Bisulphid of carbon injector in use.

Tarred paper cards.—The use of disks or pads of tarred paper for the protection of cabbage against this fly to prevent its oviposition was perfected in 1889 by Mr. W. H. Goff, who describes his cards and the manner of cutting them as follows:

The cards are cut in a hexagonal form (fig. 3), in order to better economize the material, and a thinner grade of tarred paper than the ordinary roofing felt is used, as it is not only cheaper, but being more flexible, the cards made from it are more readily placed about the plant without being torn.

The blade of the tool, which should be made by an expert blacksmith, is formed from a band of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center as shown in fig. 5. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut, the edge may be ground on a grindstone. It is important that the angles in the blade be made perfect, and that its outline represents an exact half hexagon.

¹What is known as the McGowen injector, formerly manufactured at Ithaca, N. Y., but no longer for sale, has proved most successful.

To use the tool, place the tarred paper on the end of a section of a log or piece of timber and first cut the lower edge into notches, as indicated in fig. 4, using only one angle of the tool. Then commence at the left side, and place the blade as indicated by the dotted lines, and strike at the end of the handle with a light mallet, and a complete card is made. Continue in this manner across the paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made, and properly used.

The cards should be placed about the plants at the time of transplanting. To place the card bend it slightly, to open the slit, then slip it on the center, the stem entering the slit, after which spread the card out flat, and press the points

formed by the star-shaped cut snugly around the stem.

A Wisconsin grower protected 7,000 plants and secured a splendid crop, while unprotected plants nearby would have been a complete failure if the maggots had not been picked off by hand. Others have reported similar success. One reported having lost only 25 plants out of 10,000 to 15,000 that he protected with the cards, where ordinarily he would have lost from 75 to 90 per cent of the crop.

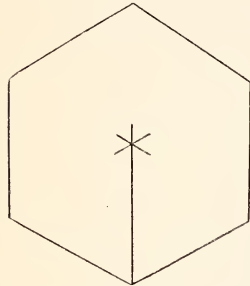


FIG. 3.—Tarred paper card in outline, one-half size (after Goff).

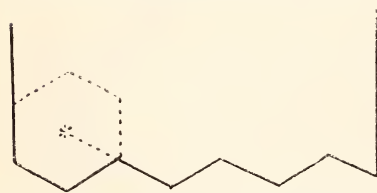


FIG. 4.—Showing how tool is used, dotted line indicating position of edge of tool (after Goff).

tightly, so that the fly is unable to obtain access to the stem for the deposition of her eggs. Cards must be renewed and the practice continued for each maggot year to be effective.¹

THE IMPORTED ONION MAGGOT.

(*Pegomya cepetorum* Meade.)²

The name "imported onion maggot" is used for this insect because there are two other onion-feeding maggots in addition to the seed-corn

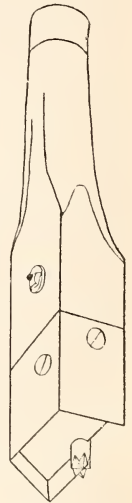


FIG. 5.—Tool for cutting cards, about one-fourth size (after Goff).

¹A Wisconsin firm has used as many as 20,000 of these cards a year, and estimates the cost of material and labor at about \$1 for the protection of 1,000 plants. This shows that it is practicable on a large scale.

²This species is commonly referred to in literature as *Anthomyia* and *Phorbia cepetorum* Bouché. From the description of the adults, according to Mr. Coquillett, it is difficult to decide whether or not Bouché's and Meade's species are identical.

maggot. Injury is accomplished by the consumption of the bulb, which induces subsequent decay of the affected portions and their very frequent destruction. It is the most important drawback to the culture of onions. The fly as well as maggot resembles preceding species, the average size being a little larger. The body of the fly is about three-sixteenths and the wing expanse nearly three-eighths of an inch. The male is gray with black bristles and hairs. It has a white face with black hairs, and there are three dark lines on the body between the wings, and a row of black spots on the abdomen. The female is a little the larger, inclined to dark yellowish, with a pale yellowish face. As in the case of the cabbage maggot, two or three generations are evidently the rule in the North.

REMEDIES.

The methods of control prescribed for the seed-corn maggot are frequently about all that are necessary for this species. In case of severe infestation the bisulphid of carbon treatment, discussed on page 5, as also other remedies advised for the cabbage maggot, are useful, with the exception of the tarred cards, which can not be conveniently or economically used on onion. The flies are probably attracted to old onion beds and to crop remnants, hence clean field methods are advisable.

NOTE.—The present circular has been prepared to facilitate correspondence, due to the fact that the three root-maggots mentioned have been extremely injurious during recent years, including the present. A more complete article on the subject is being prepared. A monographic account which has been of service in the preparation of this circular was published in 1904 by Prof. M. V. Slingerland (Bul. 78, Cornell Univ. Agl. Ex. Sta., pp. 481-577), but is now out of print.

Approved:

W. M. HAYS, *Acting Secretary.*

WASHINGTON, D. C., *June 6, 1905.*



